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Removal of pesticides with filter sand from biological rapid sand filters

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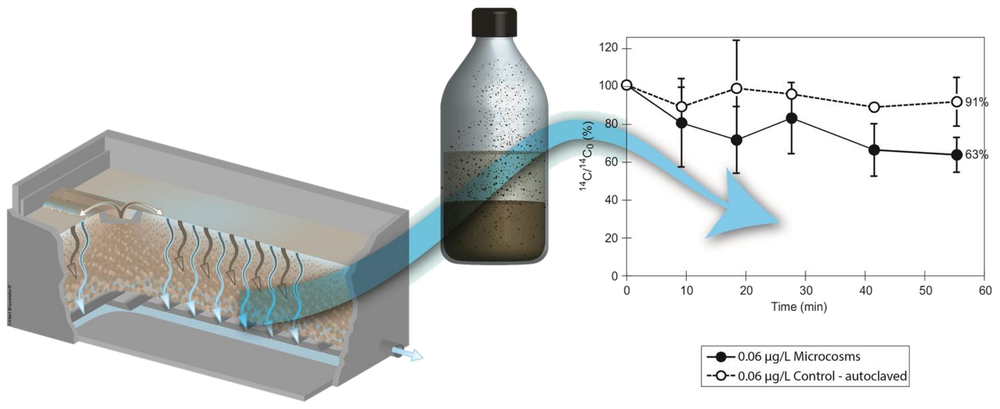
the international water association

INTRODUCTION

Pesticides and metabolites are detected in 24% of the active waterworks abstraction wells in Denmark, where the water treatment is simple consisting of aeration of anaerobic groundwater followed by filtration in rapid sand filters. Due to the sustainability of rapid sand filters it is of interest to utilise these to remove pesticides biologically.



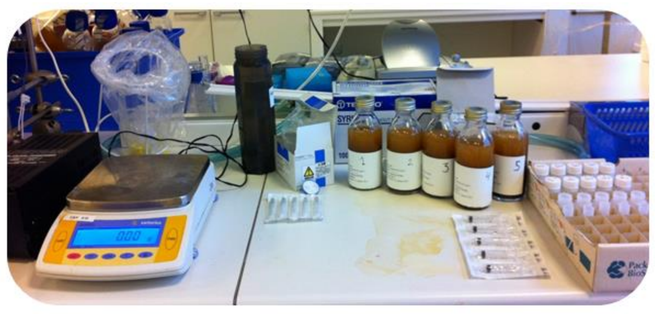
AIM

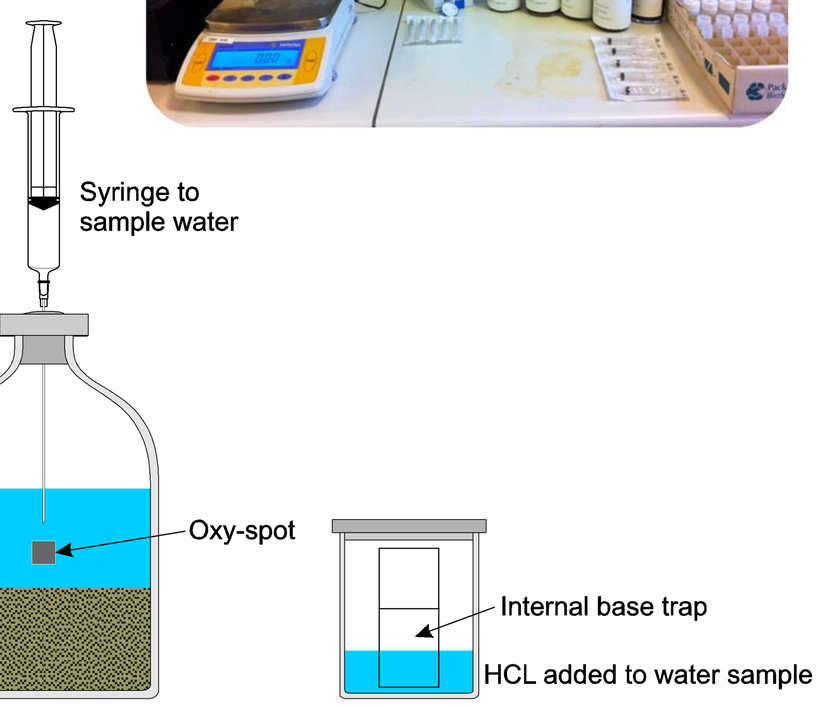
To investigate the potential and kinetics of microbial pesticide removal in rapid sand filters for drinking water treatment. Specifically:

1. Can filter sand from rapid sand filters remove MCPP, bentazone and its transformation product (TP), glyphosate and p-nitrophenol from the water phase
2. Is the potential removal rate of the herbicide bentazone, which is recalcitrant in aquifers, relevant for the contact time in rapid sand filters

METHODS

Filter sand was collected at three different waterworks and microcosms were set-up within 24 hours with filter sand, water and ^{14}C-pesticide at an environmentally realistic low initial concentration of 0.03-0.38 µg/L. The analysis for ^{14}C was based on a double vial system.





RESULTS – Removal potential

All investigated pesticides were removed from the water phase when it was in contact with filter material from all three investigated rapid sand filters. More bentzone TP and *p*-nitrophenol was removed in the microcosms compared to the abiotic controls, demonstrating the removal in the microcosms was partial biological. The microbial degradation in the filter sand from Sjælsø waterworks Plant II led to a partial mineralisation – $^{14}CO_2$ production from bentazone TP reached **8-14%**, glyphosate **42–43%** and *p*-nitrophenol **7-10%** of the initially added pesticide after six days. Thus, all three pesticides were biologically degraded in filter sand from Sjælsø waterworks Plant II.

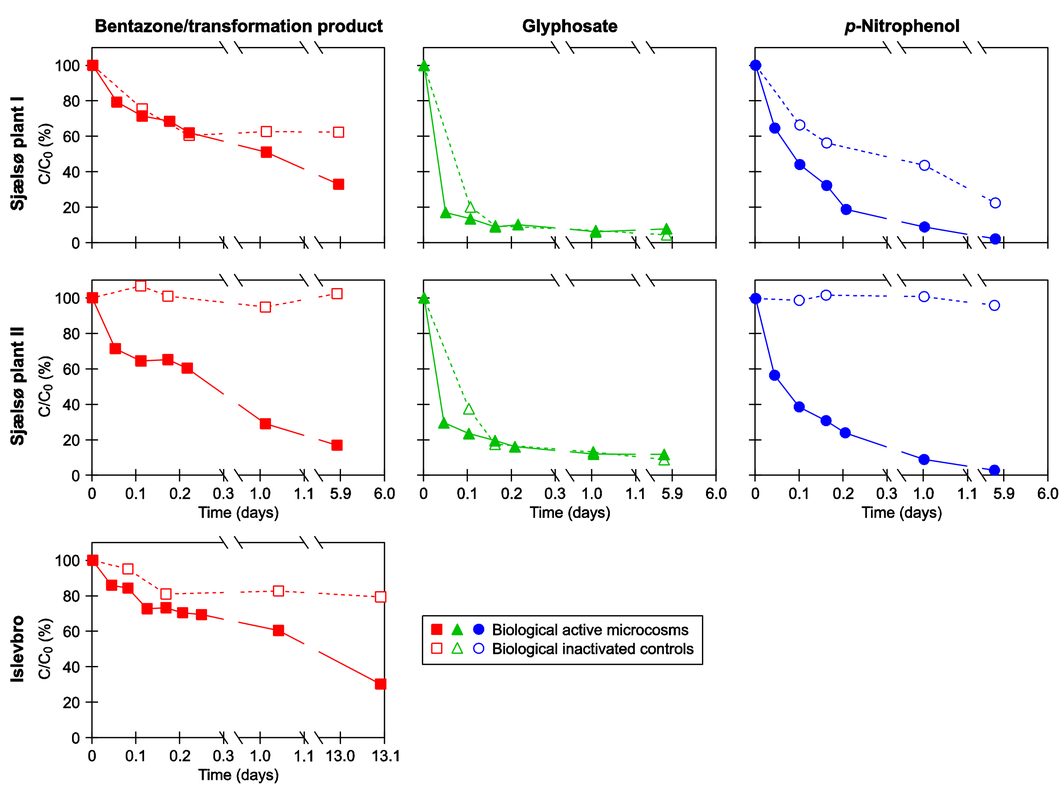


Figure 1 The fraction of ^{14}C in the water phase of the initial amount of $^{14}C_0$ in the microcosms (duplicates) and abiotic controls (modified from Hedegaard and Albrechtsen, 2014).

RESULTS – Removal kinetics

Bentazone removal with filter sand from Sjælsø waterworks Plant II was investigated during the filter contact time of one hour. During the first 60 minuts more than 35% of the initially added bentazone was removed.

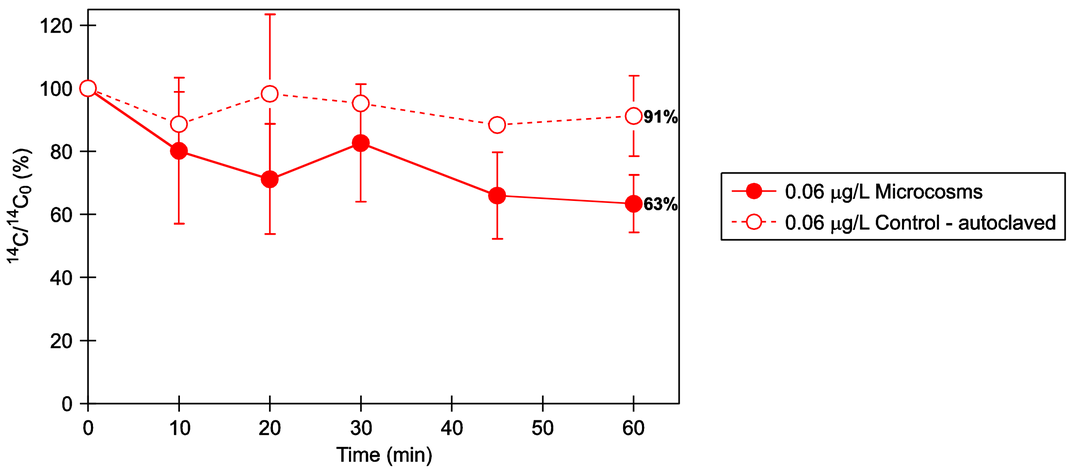


Figure 2 Mean concentrations are given as percentage of the initial concentration (0.06 µg/L) in microcosms (triplicate) and controls with autoclaved filter sand (duplicates).

CONCLUSIONS

1. An evident removal potential of MCPP, bentazone and its transformation product, glyphosate, and *p*-nitrophenol was shown in samples from rapid sand filters at three Danish waterworks. The microbial removal was largest in filter sand collected from Sjælsø Plant II
2. In filter sand from Sjælsø waterworks Plant II bentazone concentration in the water phase decreased with more than 35% of the initial concentration within 60 minutes as a result of microbial removal

Perspectives

Substantial microbial pesticide removal is possible within the contact time of rapid sand filters and thereby a potential for treatment of pesticide contaminated groundwater. This is of commercial interest due to the economical and environmental sustainability of this water treatment method.

References: Hedegaard, M. J., Albrechtsen, H.-J., 2014. Microbial pesticide removal in rapid sand filters for drinking water treatment – Potential and kinetics, Water Res 48, 71-81
Hedegaard, M. J., Arvin, E., Corfitzen, C. B., Albrechtsen, H.-J., 2014. Mecoprop (MCPP) removal in full-scale rapid sand filters at a groundwater-based waterworks, Sci Total Environ 499, 257-264

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